EVALUATION OF THE TRACY FISH COLLECTION FACILITY HOLDING TANK SCREEN RETENTION EFFICIENCY FOR JUVENILE DELTA SMELT

Investigators

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Summary

The Department of the Interior, Bureau of Reclamation (Reclamation), Tracy Fish Collection Facility (TFCF) is located at the head of the Delta-Mendota Canal (DMC) 4 km northeast of the C.W. "Bill" Jones Pumping Plant (JPP; formerly Tracy Pumping Plant) and 14.5 km northwest of Tracy, California (San Joaquin County). Reclamation's JPP exports up to 130 cubic meters per second (cms) of water south for agricultural, municipal and industrial use out of the Sacramento-San Joaquin Delta (SSJD; Arthur *et al.* 1996). The TFCF was built in 1956 by Reclamation to remove Chinook salmon (*Oncorhynchus tshawytscha*) and striped bass (*Morone saxatilis*) ≤ 20mm fork length (FL) from the DMC. Once fish are removed from the DMC, they are held in 6.1 m diameter concrete holding tanks for 8–12 h or until transportation back to the Delta is deemed necessary according to the Bates truck loading tables. The number of fish in the holding tanks and haul-out trucks are estimated using the fish count procedure in which a sub-sample of the water flowing into the tanks is taken every 2 hours. It is possible that juvenile delta smelt between 20 and 30 mm are lost through the holding tank screen during the 8–12 h holding period, which results in inaccurate estimation of the both the number of fish salvaged and the fish loading densities in the fish haul truck.

In 2004 and 2005 the fish-count procedure was tested for its efficiency in retaining juvenile delta smelt (*Hypomesus transpacificus*). This data was released in 2007 and indicates a large percentage (60%) of delta smelt 20–30 mm FL are passing through the screen commonly used to condense fish during fish counting procedures (Sutphin *et al.* 2007) and are therefore not counted. Consequently, the

number of larval and juvenile fish salvaged may be greater than estimated. From the 2007 study, it was determined that a fish count screen hole size of ≤ 2.5 mm in diameter is needed for a 20 mm FL delta smelt to not be lost through the screen holes (Sutphin *et al.* 2007). The current holding tank screen maximum diameter is 4.3 mm (Sutphin *et al.* 2007); therefore larval and juvenile fish loss from the holding tank screens is expected and may be as large as determined at the fish count station screen. The movement of entrained fish through the holding tank screens results in loss, due to the fact that fish are pumped out of the TFCF and down the DMC. In addition, this loss does not allow for accurate estimation of fish loading densities in the fish haul truck by extrapolation of fish count data. Determining which size classes of delta smelt are effectively retained in the holding tank will help us to verify the effectiveness of the current holding tank screen at retaining ≥ 20 mm delta smelt as well as gain insight on the accuracy of TFCF juvenile smelt salvage data and the accuracy of the fish loading densities in the fish haul truck.

In FY2010 a 500 µm net was used to quantify the holding tank screen fish retention of five size classes of delta smelt, between 10.0 and 34.9 mm SL, during 0, 1, 5, 15, and 30 minute swirl periods. Results of these experiments suggest that, on average, 95.7% of the 10.0–14.9 mm SL delta smelt, 95.7% of the 15.0–19.9 mm SL delta smelt, 87.4% of the 20.0–24.9 mm SL delta smelt, 98.1% of the 25.0–29.9% SL delta smelt, and 100.0% of the 30.0–34.9 mm SL delta smelt were successfully recovered in the net during the 0-minute swirl replicates. On average, 95.4% of all injected fish were recovered in the net during 0-minute swirl replicates. On average, 96.3% of the 10.0–14.9 mm SL delta smelt, 92.4% of the 15.0–19.9 mm SL delta smelt, 93.3% of the 20.0–24.9 mm SL delta smelt, and 100.0% of the 24.0–29.9 and 30.0–34.9 mm delta smelt were recovered during the 1-minute swirl replicates. On average, 96.4% of all injected fish were recovered in the net during the 1-minute swirl replicates. On average, 79.7% of the 10.0–14.9 mm SL size class, 86.9% of the 15.0–19.9 mm SL size class, 83.5% of the 20.0–24.9 mm size class, 98.2% of the 25.0–29.9 mm size class, and 100.0% of the 30.0–34.9 mm size class were recovered in the 5-minute swirl replicates, whereas 39.2%, 68.4%, and 85.4% recovery was observed for the 10.0–14.9, 15.0–19.9, and 20.0–24.9 mm SL size classes, respectively, during the 15-minute swirl replicates. On average, 89.6% and 64.3% of all injected fish were recovered during the 5-minute and 15-minute swirl replicates, respectively. During the 30-minute swirl replicate 69.3% of the 10.0–14.9 mm SL size class, 84.3% of the 15.0–19.9 mm SL size class, 80.2% of the 20.0–24.9 mm SL size class, 99.0% of the 25.0–29.9 mm size class, and 100.0% of the 30.0–34.9 mm SL size class were recovered. On average, 86.6% of all injected delta smelt were recovered during 30-minute swirl replicates. It was determined that a 26 mm SL delta smelt is retained by the current holding tank screen 100% of the time, regardless of the swirl period.

All equipment for this study was purchased in 2007 (500 µm net, net frame) although work was not possible due to construction activity at the TFCF.

Modifications (collar was added in order to fit net to frame) to the net were made in March 2008. Two new 500 µm nets were ordered and received before the FY2009 study period and were used for 2010 research activity. Collection of data was completed for this project in July 2010 and a draft report is currently being prepared.

Problem Statement

The loss of delta smelt between 20 and 30 mm through the holding tank screen results in pump mortality at the JPP as well as inaccurate estimation of the both the number of fish salvaged and the fish loading densities in the fish haul truck. The primary objective of this study is to determine the holding tank screen entrainment efficiency for five size classes (10–14.9, 15–19.9, 20–24.9, 25–29.9 and 30–34.9 mm SL) of larval and juvenile delta smelt during 0, 1, 5, 15 and 30-minute swirl periods. Determining which size classes of delta smelt are effectively retained in the holding tank will help us to verify the effectiveness of the current holding tank screen at retaining ≥ 20 mm delta smelt as well as gain insight on the accuracy of TFCF juvenile smelt salvage data along with the accuracy of the fish loading densities in the fish haul truck.

Goals and Hypotheses

Goals:

1. Determine the holding tank screen entrainment efficiency for five size classes (10–14.9, 15–19.9, 20–24.9, 25–29.9 and 30–34.9 mm TL) of larval and juvenile delta smelt during 0, 1, 5, 15 and 30-minute swirl periods.

2. Develop a probability-capture curve for larval and juvenile delta smelt based on standard length (10–14.9, 15–19.9, 20–24.9, 25–29.9 and 30–34.9 mm) and the amount of time swirled in the holding tanks (0, 1, 5, 15 and 30 minutes).

Hypotheses:

1. The holding tank screen entrainment efficiency will not increase with increasing size of juvenile delta smelt.

2. The holding tank screen entrainment efficiency for all size classes will be independent of swirl time.

Materials and Methods

Holding Tank Screen Efficiency Experiment

Fish counts of zero, one, five, fifteen, and thirty minute samples were made in TFCF holding tanks during a period of time when there was an adequate water temperature (14.6 ^{o}C–17.5 ^{o}C) and no wild delta smelt present. Cultured delta smelt were provided by the University of California at Davis' Fish Culture and Conservation Laboratory (FCCL), transported to the TFCF in 18.9-L black buckets with lids, and held in an ambient Delta water bath prior to insertion. A 500-um cone-shaped plankton net was placed in the drain located behind the screen. Unmeasured cultured delta smelt (400) were inserted into a full static holding tank using a water-to-water method in which the 18.9-L black buckets was lowered with a rope and poured. Holding tank valves were put into operation to initiate collection and water flow through the holding tank screen. During the specified collection period, flow was regulated using holding tank pumps (one or two) to mimic typical flow rates when wild delta smelt are salvaged. Flow rates (cms), tank water depths (m), and temperature (^{o}C) were recorded. After the collection period, the holding tank was drained to approximately 0.6 m deep. The plankton net was lifted out of the drain pit and sample #1 (fish that were not effectively withheld in the holding tank) was collected by rinsing the net into 18.9-L buckets. The plankton net was then reinserted into the drain pit and the "collect" valve was used to fill the holding tank until water levels inside and outside of the holding tank screen were equal. This process eliminated the problem of a sudden force of water lifting our net frame and the possible loss of fish. Once equilibrium was achieved, the holding tank screen was lifted up and sample #2 (fish that were effectively withheld in the holding tank) was collected in our net. The holding tank was then rinsed using a high pressure hose and our net was rinsed into 18.9-L buckets. The samples were then separately consolidated into 1 fine meshed (0.39 mm) dipnet by pouring the contents of each 18.9-L bucket into the dipnet. The samples were then bathed for 5 minutes in Rose Bengal for staining. After this, the samples were thoroughly rinsed and placed into a pyrex dish on a light table. All delta smelt were picked out of the samples. Standard length, fork length, total length and maximum depth (from the insertion of the first dorsal ray to the insertion of the first anal ray) were measured for all delta smelt collected using a Leica™ MZ7_5 stereomicroscope (Leica Microsystems, Bannockburn, IL) equipped with a micrometer. Bycatch of fish $\geq$ 20 mm were identified to species and measured (FL).

Data Analyses

Three replicates for each size class and swirl time were completed. Approximately 500 fish at each size/time combination in order to estimate efficiency within 5% with a power of 0.8. Logistic regression will be used to determine if flow rate, depth, fish size and swirl time significantly change the probability of capture. If these independent variables are significant, a probability-capture curve, with 95% confidence intervals, will then be developed using the Logit link function. A probability-capture curve will allow us to determine the holding tank screen entrainment efficiency, for the six size classes of juvenile delta smelt, during 0, 1, 5, 15 and 30-minute swirl periods. Data analysis will be completed by August 2011.

Coordination and Collaboration

All experiments will be coordinated with the TFCF Fish Diversion Operators (Joel Imai) along with the TFCF Biology staff (Brent Bridges). During data collection it will be necessary to utilize a TFCF holding tank and the bucket hoist. Participation and inclusion of research-related updates will be provided at regularly scheduled Tracy Technical Advisory Team (TTAT) and/or Central Valley Fish Facilities Review Team (CVFFRT) meetings.

Endangered Species Concerns

We will be using larval and juvenile stages of domestically reared delta smelt and have timed the tests so that they do not coincide with periods when wild ESA listed delta smelt are present. However, incidental “take” of ESA listed Chinook salmon and/or steelhead trout (*O. mykiss*) is likely to occur during the tests. If collected, ESA listed Chinook salmon and steelhead trout will be measured and released alive back into the normal salvage operations. All larval and/or juvenile delta smelt that are encountered during testing will not be released alive back into the Delta.

Dissemination of Results (Deliverables and Outcomes)

A Tracy Series Report volume will be prepared and published upon completion of the study. Updates and presentations of progress will be provided internally and upon request by TTAT and other interagency technical forums. A draft report is currently being prepared and is tentatively scheduled to be completed by September 2012. A final draft report will be finished by December 2013.

Literature Cited

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